Topic: Vertical motion, ball thrown up from the ground

Question: A ball is thrown straight up from the ground with initial velocity $v_0 = 64$ ft/s. What is the ball's maximum height, and what is its velocity when it hits the ground?

Answer choices:

A The ball's maximum height is 32 ft and the ball's velocity when it hits the ground is -32 ft/s.

B The ball's maximum height is 32 ft and the ball's velocity when it hits the ground is -64 ft/s.

C The ball's maximum height is 64 ft and the ball's velocity when it hits the ground is -64 ft/s.

D The ball's maximum height is 64 ft and the ball's velocity when it hits the ground is -32 ft/s.

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Solution: C

To solve a vertical motion problem where a ball is thrown up from the ground, use the formula

$$y(t) = -\frac{1}{2}gt^2 + v_0t + y_0$$

where $y(t)$ is the position of the ball at time t, g is the gravitational constant, t is the time, v_0 is the initial velocity and y_0 is the initial position.

In this type of problem, $y_0 = 0$ since the ball is thrown up from the ground, and $t_0 = 0$ is the initial time.

To solve, start by using $g = 32$ ft/s², $v_0 = 64$ ft/s, and $y_0 = 0$.

$$y(t) = -\frac{1}{2}gt^2 + v_0t + y_0$$

$$y(t) = -\frac{1}{2}(32)t^2 + (64)t + 0$$

$$y(t) = -16t^2 + 64t$$

The question is looking for the ball's maximum height and its final velocity when it hits the ground. To find final velocity, set the position function equal to 0, since height is 0 when the ball hits the ground.

$$y(t) = -16t^2 + 64t$$

$$0 = -16t^2 + 64t$$

$$0 = -16t(t - 4)$$

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$$t = 0, 4$$

We know that the height is 0 when the ball is initially thrown up from the ground at $t = 0$, which means it hits the ground again when $t = 4$.

To find velocity when the ball hits the ground at $t = 4$, we need to find the velocity function by taking the derivative of the position function.

$$y(t) = -16t^2 + 64t$$

$$y'(t) = v(t) = -32t + 64$$

Now we'll plug in $t = 4$ to find velocity when the ball hits the ground.

$$v(4) = -32(4) + 64$$

$$v(4) = -128 + 64$$

$$v(4) = -64$$

Now we need to find the time when the ball is at its maximum height. This happens when the velocity is 0, so we'll set the velocity function equal to 0.

$$0 = -32t + 64$$

$$-32t = -64$$

$$t = 2$$

Finally we can take $t = 2$ and $y(t) = -16t^2 + 64t$ and find the position of the ball at its maximum height.

$$y(2) = -16(2)^2 + 64(2)$$

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$$y(2) = -64 + 128$$

$$y(2) = 64$$

The ball's maximum height is 64 ft and ball's velocity when it hits the ground is -64 ft/s.

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Topic: Vertical motion, ball thrown up from the ground

Question: A ball is thrown straight up from the ground with initial velocity $v_0 = 128$ ft/s. What is the ball's maximum height, and what is its velocity when it hits the ground?

Answer choices:

A The ball's maximum height is 256 ft and the ball's velocity when it hits the ground is -256 ft/s.

B The ball's maximum height is 128 ft and the ball's velocity when it hits the ground is -128 ft/s.

C The ball's maximum height is 128 ft and the ball's velocity when it hits the ground is -256 ft/s.

D The ball's maximum height is 256 ft and the ball's velocity when it hits the ground is -128 ft/s.

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Solution: D

To solve a vertical motion problem where a ball is thrown up from the ground, use the formula

$$y(t) = -\frac{1}{2}gt^2 + v_0t + y_0$$

where $y(t)$ is the position of the ball at time t, g is the gravitational constant, t is the time, v_0 is the initial velocity and y_0 is the initial position.

In this type of problem, $y_0 = 0$ since the ball is thrown up from the ground, and $t_0 = 0$ is the initial time.

To solve, start by using $g = 32$ ft/s², $v_0 = 128$ ft/s, and $y_0 = 0$.

$$y(t) = -\frac{1}{2}gt^2 + v_0t + y_0$$

$$y(t) = -\frac{1}{2}(32)t^2 + (128)t + 0$$

$$y(t) = -16t^2 + 128t$$

The question is looking for the ball's maximum height and its final velocity when it hits the ground. To find final velocity, set the position function equal to 0, since height is 0 when the ball hits the ground.

$$y(t) = -16t^2 + 128t$$

$$0 = -16t^2 + 128t$$

$$0 = -16t(t - 8)$$

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$$t = 0, 8$$

We know that the height is 0 when the ball is initially thrown up from the ground at $t = 0$, which means it hits the ground again when $t = 8$.

To find velocity when the ball hits the ground at $t = 8$, we need to find the velocity function by taking the derivative of the position function.

$$y(t) = -16t^2 + 128t$$

$$y'(t) = v(t) = -32t + 128$$

Now we'll plug in $t = 8$ to find velocity when the ball hits the ground.

$$v(8) = -32(8) + 128$$

$$v(8) = -256 + 128$$

$$v(8) = -128$$

Now we need to find the time when the ball is at its maximum height. This happens when the velocity is 0, so we'll set the velocity function equal to 0.

$$0 = -32t + 128$$

$$-32t = -128$$

$$t = 4$$

Finally we can take $t = 4$ and $y(t) = -16t^2 + 128t$ and find the position of the ball at its maximum height.

$$y(4) = -16(4)^2 + 128(4)$$

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$$y(4) = -256 + 512$$

$$y(4) = 256$$

The ball's maximum height is 256 ft and ball's velocity when it hits the ground is -128 ft/s.

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Topic: Vertical motion, ball thrown up from the ground

Question: Find maximum height.

An apple is thrown straight upward from the ground with an initial velocity of 100 m/s. Given the apple's position function and assuming constant gravity, find the maximum height that the apple attains.

$$s(t) = -\frac{1}{2}gt^2 + v_0t + y_0$$

Answer choices:

A 520.1 m

B 512.0 m

C 51.02 m

D 510.2 m

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Solution: D

To solve this problem, we'll use the following steps.

1. Generate a position function for the apple.
2. Take the derivative of the position function. This will be the velocity function.
3. Set the derivative equal to zero and solve for time. This is where the apple attains maximum height.
4. Plug the value for time back into the position function to find it's height at that point.

We can start by generating our position function. Since gravity is 9.8 m/s^2 and we were told that $v_0 = 100$ and $y_0 = 0$ (initial position of the apple on the ground), we can generate a position function using $s(t)$ and get

$$s(t) = -\frac{1}{2}(9.8)t^2 + 100t + 0$$

$$s(t) = -4.9t^2 + 100t$$

To get velocity, we'll take the derivative of the position function.

$$v(t) = s'(t) = -9.8t + 100$$

Setting $v(t) = 0$ and solving for t will give us the time when the apple attains maximum height.

$$-9.8t + 100 = 0$$

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$$9.8t = 100$$

$$t = 10.2$$

Plugging $t = 10.2$ back into our position function, we'll find the maximum height of the apple.

$$s(10.2) = -4.9(10.2)^2 + 100(10.2)$$

$$s(10.2) = 510.2$$

The maximum height the apple attains is 510.2 m.

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